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(54) **PORTABLE HEATING SYSTEM AND METHOD FOR PEST CONTROL**

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(51) **Int. Cl.**

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A01M 1/20	(2006.01)
F24H 3/06	(2006.01)

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CPC ***A01M 1/2094*** (2013.01); ***A01M 1/24*** (2013.01); ***E04B 1/72*** (2013.01)

(58) **Field of Classification Search**

CPC A01M 1/2094; A01M 1/24; A01M 9/00; A61L 2/04

USPC ..... 43/132.1; 122/20 R, 4 A; 392/373; 165/299, 64

See application file for complete search history.

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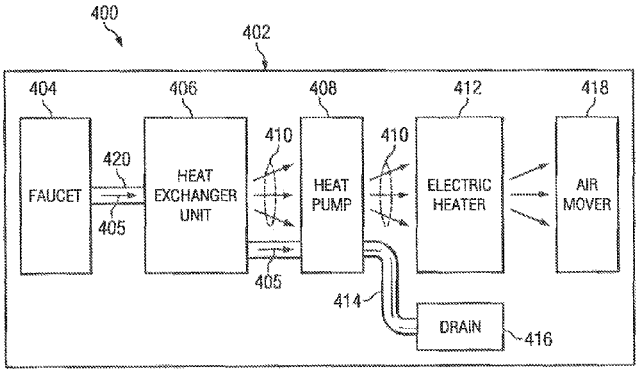
(57) **ABSTRACT**

A method for killing pests in an affected area of a structure, comprises positioning a heat exchanger unit within an affected area, coupling a first end of an inlet hose to a faucet, and coupling a second end of the inlet hose to an inlet port of the heat exchanger unit such that the heat exchanger unit may receive a flow of water from the faucet. The heat exchanger unit generates heated air by transferring heat from the flow of water received from the faucet to air flowing through the heat exchanger unit. The method continues by positioning an electric heater proximate to the heat exchanger unit, the electric heater operable to further heat the heated air emitted by the heat exchanger unit to a target temperature greater than 120 degrees Fahrenheit, the further heated air being emitted into the affected area.

13 Claims, 3 Drawing Sheets



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F24D 3/08	(2006.01)
E04B 1/72	(2006.01)

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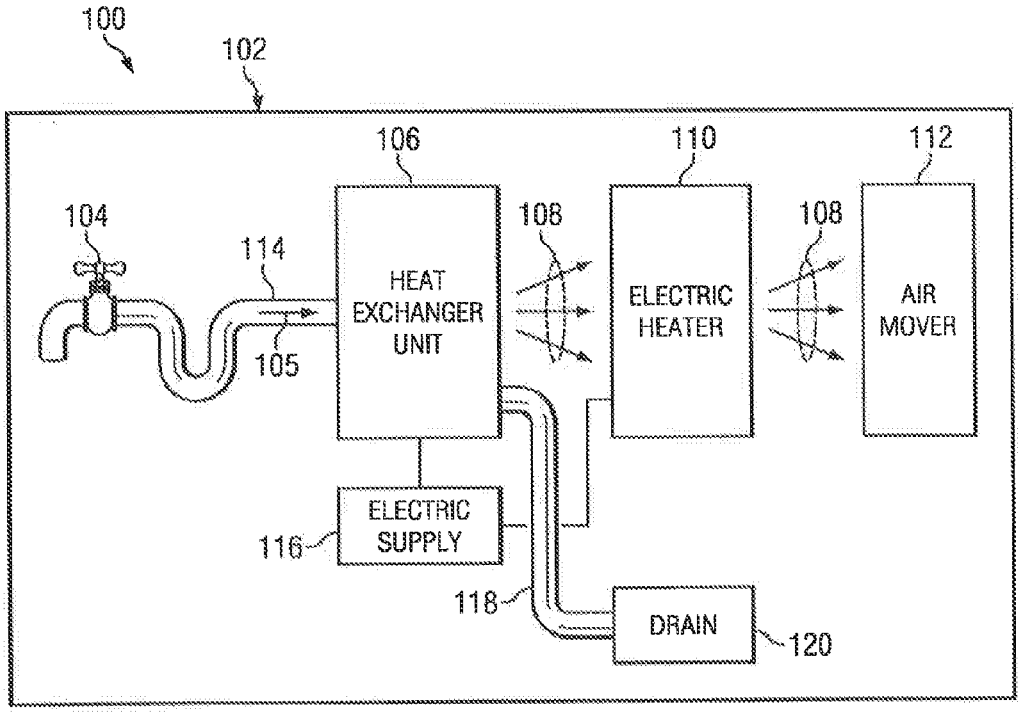
100
102
106
110
112
104
114
HEAT EXCHANGER UNIT
108
ELECTRIC HEATER
108
AIR MOVER
105
ELECTRIC SUPPLY
116
118
DRAIN
120

FIG. 1

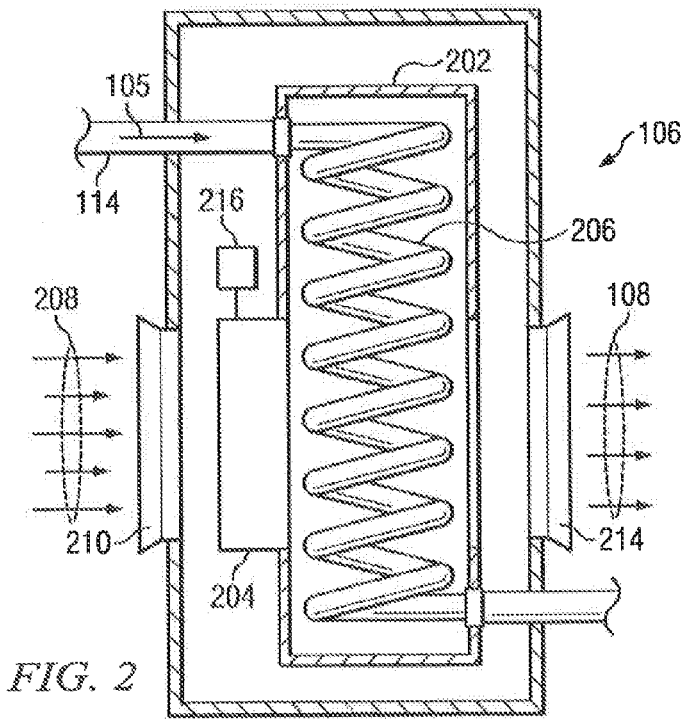
202
105
106
114
216
206
208
108
210
214
204

FIG. 2

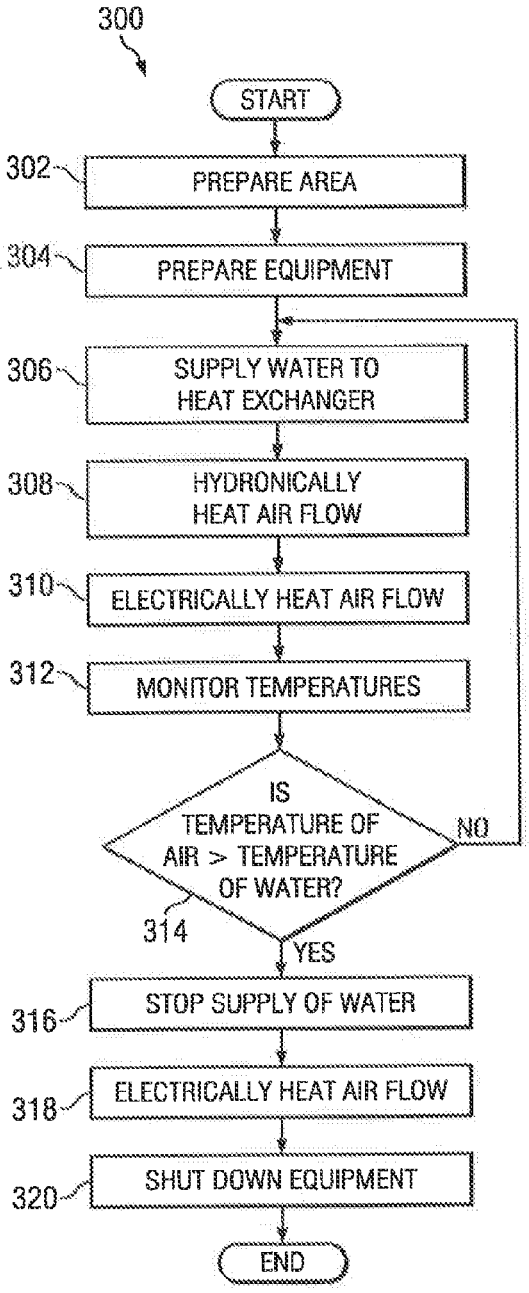
300
START
302
PREPARE AREA
304
PREPARE EQUIPMENT
306
SUPPLY WATER TO HEAT EXCHANGER
308
HYDRONICALLY HEAT AIR FLOW
310
ELECTRICALLY HEAT AIR FLOW
312
MONITOR TEMPERATURES
IS TEMPERATURE OF AIR > TEMPERATURE OF WATER?
NO
314
YES
316
STOP SUPPLY OF WATER
318
ELECTRICALLY HEAT AIR FLOW
320
SHUT DOWN EQUIPMENT
END

FIG. 3

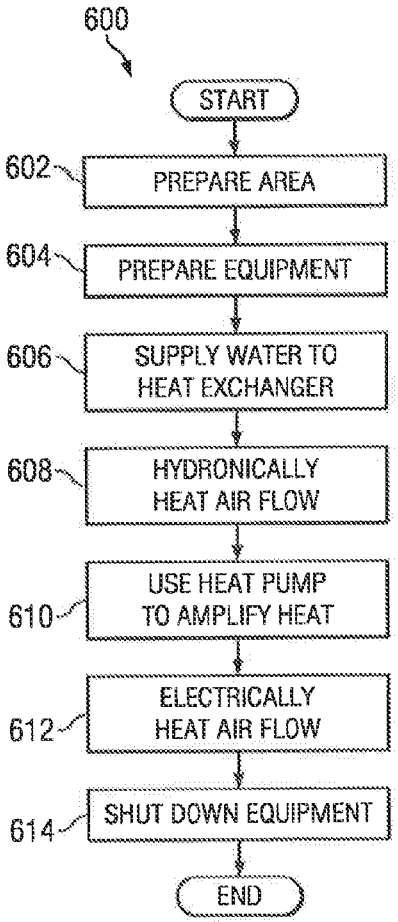
600
START
602
PREPARE AREA
604
PREPARE EQUIPMENT
606
SUPPLY WATER TO HEAT EXCHANGER
608
HYDRONICALLY HEAT AIR FLOW
610
USE HEAT PUMP TO AMPLIFY HEAT
612
ELECTRICALLY HEAT AIR FLOW
614
SHUT DOWN EQUIPMENT
END

FIG. 6

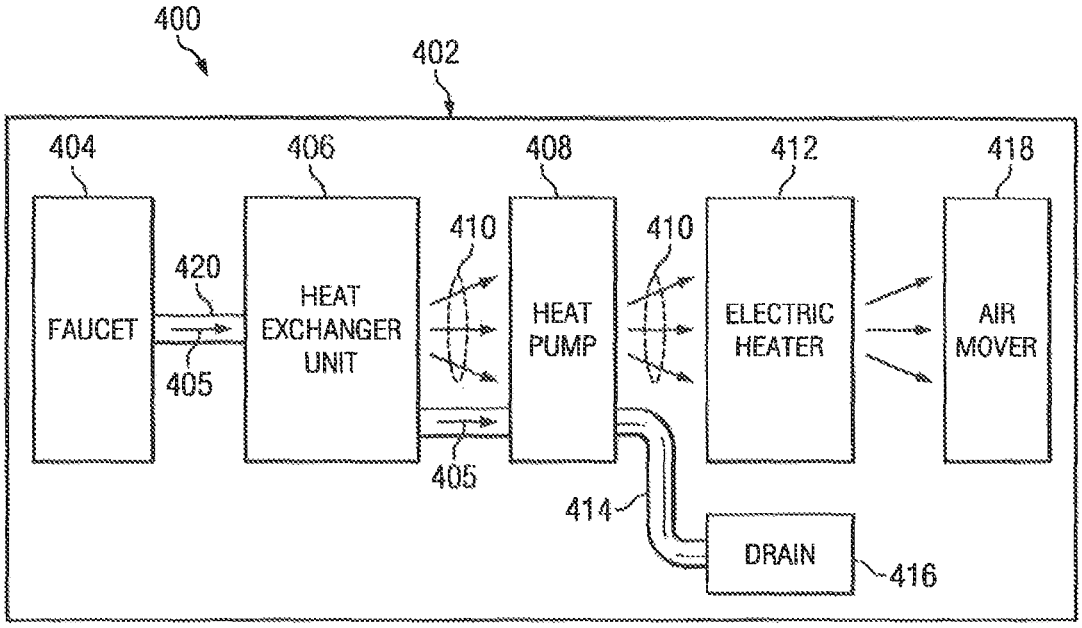
400
402
404
406
408
412
418
FAUCET
420
405
HEAT EXCHANGER UNIT
410
405
HEAT PUMP
410
ELECTRIC HEATER
AIR MOVER
414
DRAIN
416

FIG. 4

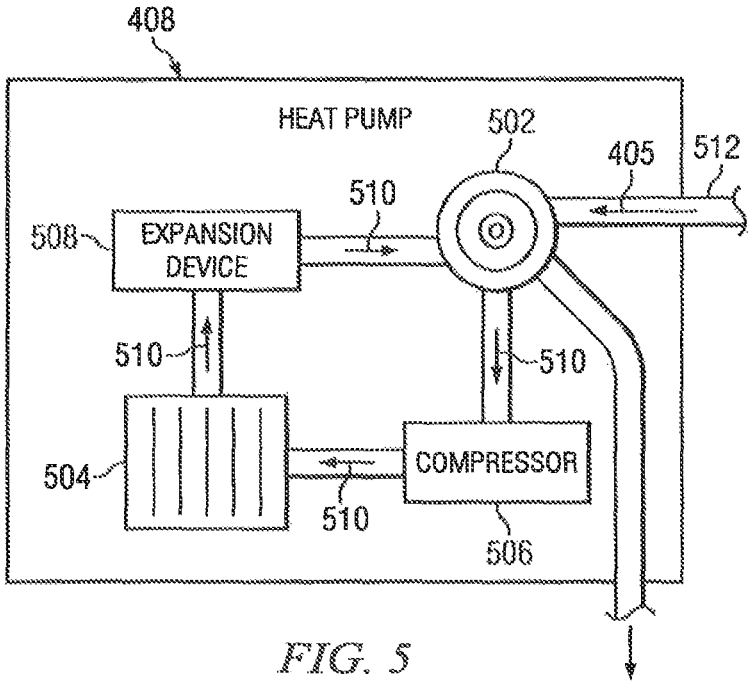
408
HEAT PUMP
502
405
512
510
508
EXPANSION DEVICE
510
510
504
COMPRESSOR
510
506

FIG. 5

PORTABLE HEATING SYSTEM AND METHOD FOR PEST CONTROL

RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/013,560, filed Jan. 25, 2011, entitled "Portable Heating System and Method for Pest Control," the entire disclosure of which is hereby incorporated by reference.

TECHNICAL FIELD

This invention relates generally to pest control and more particularly to a portable heating system and method for killing bed bugs in an affected area.

BACKGROUND OF THE INVENTION

It is not uncommon for pests such as bed bugs and other insects to infest structures or other areas that are also inhabited or otherwise used by humans. This is particularly true in enclosed spaces that are located within certain climates and/or enclosed spaces that are frequented by the public. The insects, which generally hide during the day, emerge from cracks and crevices at night to feast on human blood while the human inhabitants are asleep. For example, hotels may become infested with bed bugs or other pests when those insects are brought in by overnight guests. The problem is not isolated to hotels that service over night visitors, however. Other spaces that may become infested include office and commercial buildings, private dwellings, and vehicles. Accordingly, the need exists for effective and efficient systems and methods for killing bed bugs and other pests within an enclosed area. Systems and methods for killing bed bugs and other pests, however, have proven inadequate in various respects.

SUMMARY OF THE INVENTION

According to embodiments of the present disclosure, disadvantages and problems associated with previous systems for killing pests such as bed bugs in an affected area may be reduced or eliminated.

In certain embodiments, a system for killing pests in an affected area includes a heat exchanger unit and an electric heater. The heat exchanger unit is placed within the affected area and is coupled to a faucet. The heat exchanger unit is configured to receive a flow of water from the faucet and to emit heated air by transferring heat from the flow of water to air flowing through the heat exchanger unit. The electric heater further heats the air emitted by the heat exchanger unit to a target temperature greater than 120 degrees Fahrenheit.

Particular embodiments of the present disclosure may provide one or more technical advantages. For example, the temperature within an affected area may be elevated to a temperature suitable for killing bed bugs and other pests without causing damage to the structure or its contents. In particular, the temperature of an affected area may be thoroughly and uniformly heated to a temperature that is greater than 120 degrees Fahrenheit. Such a temperature has been shown to be effective in killing bed bugs and other pests that have infested the area without causing damage to the affected area or its contents.

In certain embodiments, all or a portion of the heat necessary to elevate the temperature of an affected area to a temperature suitable for killing bed bugs and other pests may be extracted from water that is already available to the affected area. For example, a flow of heated water may be supplied from a sink faucet, a shower faucet, a bathtub faucet, or any other suitable source of heated water. Once heat has been extracted from the flow of water, the flow of water may be directed to an available drain, such as a sink, bathtub, or toilet. Because all or a portion of the heat necessary to elevate the temperature of an affected area to a temperature suitable for killing bed bugs is extracted from water that is already available to the affected area, certain embodiments of the present disclosure may allow for heating of affected areas for which alternative sources of heat are unavailable or insufficient (e.g., high rise apartment buildings).

Certain embodiments of the present disclosure may include some, all, or none of the above advantages. One or more other technical advantages may be readily apparent to those skilled in the art from the figures, descriptions, and claims included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

To provide a more complete understanding of the present invention and the features and advantages thereof, reference is made to the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates an example system for pest control, according to certain embodiments of the present disclosure;

FIG. **2** illustrates an example heat exchanger unit for use in conjunction with the system depicted in FIG. **1**, according to certain embodiments of the present disclosure;

FIG. **3** illustrates an example method for pest control, according to certain embodiments of the present disclosure;

FIG. **4** illustrates an example heat pump system for pest control, according to certain embodiments of the present disclosure;

FIG. **5** illustrates an example heat pump unit for use in conjunction with the heat pump system depicted in FIG. **4**, according to certain embodiments of the present disclosure; and

FIG. **6** illustrates an example heat pump method for pest control, according to certain embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an example system **100** for pest control, according to certain embodiments of the present disclosure. In general, system **100** includes equipment and components for heating at least a portion of an affected area **102** and its contents to a temperature sufficient to kill bed bugs and other insects that may have infested the affected area **102**. For example, the temperature of affected area **102** may be increased to a temperature that is substantially equal to or greater than 120 degrees Fahrenheit, in certain embodiments. The term "affected area" is intended to include any enclosed space that may become infested with bed bugs or other insects or pests. In certain embodiments, affected area **102** may include a budding or structure. For example, affected area **102** may include a hotel, an office space, a commercial building, or a private dwelling such as a house or apartment building. In other embodiments, affected area **102** may include a portion of a building or structure. For example, affected area **102** may include a room in a hotel, an office within an office building, a room within a house, or an apartment with in an apartment building. However, affected area **102** is not limited to a budding or structure or portion thereof. Likewise, affected area **102** may include any area requiring treatment for bed bugs or other pests whether that area is interior to or exterior to a

building or other structure. Affected area **102** may be considered an acute infestation site where there has been visual confirmation of a nesting area of bedbugs or other insects, or where a trained scent detection dog has alerted to the presence of bedbugs. Generally, a nesting area may include several to dozens of bed bugs.

Although a minimum temperature of 120 degrees Fahrenheit may be sufficient to kill bed bugs and other insects, in some circumstances, it may be desirable to heat the air to a higher temperature. For example, heating the ambient air within affected area **102** to only the minimum temperature may be insufficient to ensure that all contents within affected area **102** are adequately and thoroughly heated throughout to the minimum temperature. Accordingly, in a particular embodiment, the temperature of affected area **102** may be further increased to ensure that hard-to-heat areas and the contents of these areas are thoroughly heated to the minimum temperature of 120 degrees Fahrenheit. In such an embodiment, the temperature of affected area **102** may be increased to a target temperature of at least 140 degrees Fahrenheit. Heating the ambient air to a temperature of 140 degrees or greater may more readily ensure that the entirety of affected area **102** and all of its contents are thoroughly heated to at least the minimum temperature of 120 degrees Fahrenheit that is required to effectively treat the affected area for bed bugs.

Generally, a faucet **104** provides a supply of water **105** that is used as a heat source. The faucet **104** may be within affected area **102** or may be external to affected area **102**. The hot water **105** may be transported from faucet **104** via one or more tubes or hoses to a heat exchanger unit **106** within the affected area **102**. Heat exchanger unit **106** may transfer the heat from water **105** to the ambient air. Heated air **108** may be emitted to an electric heater **110** that operates to amplify the heat. An air mover **112** may then used to circulate the heated air **108** within affected area **102**. Water **105** from the heat exchanger unit may be transported to a drain such as a bathtub, toilet, sink, or in floor drain. As will be described in more detail below, faucet **104**, heat exchanger unit **106**, electric heater **110**, air mover **112**, and water **105** received by these components may cooperate to heat affected area **102** to a target temperature that is sufficient to kill pests such as bed bugs and other insects.

In certain embodiments, faucet **104** is a preexisting water source within affected area **102**. For example, faucet **104** may include a conventional faucet such as a sink faucet, a shower faucet, a bathtub faucet, or any other suitable source of heated water. In other embodiments, faucet **104** may be a water source external to but proximate to affected area **102**. During the treatment of affected area **102**, faucet **104** may be turned on such that water **105** is continuously provided to heat exchanger unit **106**. Faucet **104** may be turned or otherwise set such that (1) faucet **104** provides the water **105** at the highest possible temperature, and/or (2) faucet **104** provides water **105** at a maximum possible flow rate.

In certain embodiments, water may be supplied to faucet **104** from a water heating unit, such as water heater or boiler, within a building or other structure, the water heating unit being set to heat the supplied water to a temperature that is comfortable for occupants. For example, the water heating unit may be set to a temperature of approximately 120-130 degrees Fahrenheit. Water heated to a temperature within this range may be easily tolerated by occupants of the building or other structure. Accordingly, where water is provided to the faucet **104** from a water heating unit that is set to a temperature of approximately 120-130 degrees Fahrenheit, faucet **104** may provide water **105** to heat exchanger unit **106** at like temperatures. In a particular embodiment, faucet **104** may provide water **105** to heat exchanger unit **106** at a temperature of approximately 125 degrees Fahrenheit.

In other embodiments, the temperature of water **105** may be adjusted based on the temperature to be achieved within affected area **102** during the treatment process. For example, although an ambient air temperature of approximately 120 degrees Fahrenheit may be sufficient in the killing of bed bugs and other insects, a higher temperature may be desired in certain instances. Accordingly, where the structure can be vacated of all occupants or where all occupants can be directed not to use the water provided to the area, the temperature setting of the water heating unit within the structure or other area may be increased. For example, the temperature setting of the water heating unit may be set to a temperature that is substantially equal to or greater than 140 degrees Fahrenheit. In such an embodiment, faucet **104** may provide water **105** to heal, exchanger unit **106** at a temperature of at least 140 degrees Fahrenheit.

A hose **114** may be used transport water **105** from faucet **104** to heat exchanger unit **106**. Accordingly, a first end of hose **114** may couple to faucet **104**, and a second end of hose **114** may couple to heat exchanger unit **106**. In certain embodiments, the respective ends of hose **114** may be configured or have an adapter that allows hose **114** to be easily connected to common plumbing fixtures. For example, hose **114** may include a quick-connect adapter having standard threaded plumbing connections to attach to the faucet **104** and the heat exchanger unit **106**. The diameter of hose **114** may be selected to handle the volume of water supplied by faucet **104** and for maintaining a desired fluid pressure within hose **114**. For example, hose **114** may have a diameter within a range of approximately ¾ to 1 inch, in particular embodiments. It is generally recognized, however, hose **114** may be of any suitable diameter for maintaining the desired fluid pressure within system **100**. Likewise, heat exchanger unit **106** may include an inlet port of any size and configuration to facilitate the coupling of hose **114** to heat exchanger unit **106**.

FIG. **2** illustrates an example heat exchanger unit **106** for use in conjunction with the system **100** depicted in FIG. **1**, according to certain embodiments. As depicted, heat exchanger unit **106** includes both a heat exchanger component **202** and a power fan **204**, which may be powered by an electric supply **116**. Heat exchanger component **202** may include a fluid-to-air heat exchanger or radiator that transfers thermal energy from fluid **105** to air that is blown through heat exchanger component **202** by fan **204**. In this manner, heat exchanger unit **106** may be used to heat the ambient air in affected area **102** to the desired temperature. Where heat exchanger unit **106** includes both a heat exchanger component **202** and a power fan **204**, heat exchanger unit **106** may be referred to as a "fan coil."

Specifically, and as discussed above, water **105** is received by heat exchanger unit **106** via supply line **114**. The heated water **105** is received at a first temperature and is circulated through one or more tubes or pipes **206** in heat exchanger component **202**. While water **105** is being circulated through pipe coil **206**, for example, fan **204** is operated to draw in ambient air **208** from the area surrounding heat exchanger unit **106**. The air **208** may be drawn in through an opening **210** and may be received at a second temperature that is generally equal to the temperature of the ambient air within affected area **102**. As the air **208** is blown across pipe coil **206** of heat exchanger component **202**, the heat in water **105** conducts to the outer surface of pipe coil **206** and is transferred into the cooler ambient air **208**. The difference in the temperature between the heated water **105** at the first temperature and the

ambient air **208** at the second temperature may cause the temperature of ambient air **208** to increase as it is blown over pipe coil **206** by fan **204**. The heated air **108** then exits heat exchanger unit **106** through an exit opening **214** and is pushed by fan **204** into affected area **102**.

In certain embodiments, heat exchanger unit **106** may include a thermostat **216** for controlling heat output. Thermostat **216** may operate to measure the temperature of ambient air **208** as it is being received by heat exchanger unit **106**. Thermostat **216** may also be used to selectively control fan **204** in response to the temperature of ambient air **208** as it is received by heat exchanger unit **106**. Specifically, in certain embodiments, thermostat **216** may be set to cycle fan **204** off when the temperature of air **208** being received exceeds an upper limit. Thermostat **216** may also be set to cycle fan **204** on when the temperature of air **208** being received dips below a lower limit. For example, where a target temperature in the range of 135 to 145 degrees Fahrenheit is desired for the killing of bed hugs within affected area **102**, thermostat **216** may be set to cycle off fan **204** when the temperature of air **208** being received in opening **210** exceeds 145 degrees Fahrenheit. Thermostat **216** may be then be set to cycle fan **204** on when the temperature of air **208** being received in opening **210** dips below 135 degrees Fahrenheit. Alternatively, where a target temperature of approximately 140 degrees Fahrenheit is desired, thermostat **216** may be set to cycle on fan **204** when the temperature of the ambient air **208** being received by heat exchanger unit **106** is equal to or below 140 degrees Fahrenheit and cycle off fan **204** when the temperature of ambient air **208** being received by heat exchanger unit **106** is above 140 degrees Fahrenheit. As will be described in more detail below, an infrared and/or wireless thermometer may be used to verify that affected area **102** is thoroughly heated to the desired temperature.

Because heat exchanger unit **106** operates to transfer heat from water **105** to the ambient air in affected area **102**, the air **108** being emitted by heat exchanger unit **106** is of a higher temperature than the air being received by heat exchanger unit **106**. In some embodiments, heat exchanger unit **106** may be sufficient by itself to thoroughly heat the affected area **102** to the target temperature. For example, where the temperature of water **105** is substantially equal to or greater than 140 degrees Fahrenheit, heat exchanger unit **106** may efficiently heat affected area **102** to a target temperature that is greater than 120 degrees Fahrenheit. Even where the temperature of water **105** is less than 140 degrees Fahrenheit, heat exchanger unit **106** may be sufficient to heat affected area **102** to the target temperature if allowed to run long enough.

In certain embodiments, however, it may be desirable to incorporate one or more additional heat sources into system **100**. Additional heat sources may allow the target temperature to be achieved in a more efficient and more timely manner. Returning to FIG. **1**, system **100** is depicted as including an electric heater **110** as an additional heat source. Electric heater **110** may include any electrical appliance that converts electrical energy into heat. In a particular embodiment, an electrical resistor or other electrical heating element may operate to convert the electrical energy received from an electric supply **116** into heat energy. Electric supply **116** may include one or more AIC electrical outlets. Accordingly, in certain embodiments, electric heater **110** may be configured to plug into a standard 120V, 208V, 230V, or any other suitable electrical outlet. Where multiple components of system **100** require electricity from electric supply **116**, the components may be plugged into outlets on different branch circuits. For example, heat exchanger unit **106** may be plugged into an outlet on one branch circuit while electric heater **110** is plugged into an outlet on another branch circuit.

When included in system **100**, electric heater **110** may operate to further increase the temperature of air **108** emitted by heat exchanger unit **106**. For example, electric heater **110** may be used to bring the temperature of the ambient air in affected area **102** up to the target temperature at a faster rate than in a system that has only a heat exchanger unit **106** as a heat source. Additionally or alternatively, where the temperature of water **105** is not high enough to effectively bring the temperature of the affected area **102** to the target temperature, electric heater **110** may operate to "boost" or "amplify" the heated air emitted by heat exchanger unit **106**. For example, where the temperature of water **105** is less than 140 degrees Fahrenheit, in certain embodiments, electric heater **110** may be used to for amplifying the heat emitted by heat exchanger unit **106** to allow the ambient air in the affected area **102** to be brought up to the target temperature.

In certain embodiments, the temperature of the air and/or water may be monitored to prevent heat exchanger unit **106** becoming counter productive. For example, as the temperature of the ambient air within affected area **102** surpasses the temperature of water **105** being received by heat exchanger unit **106**, the operation of heat exchanger unit **106** may actually become counterproductive. Specifically, since heat exchanger unit **106** operates to transfer heat from the hotter medium to the cooler medium, as the temperature of the air surpasses the temperature of fluid **105**, heat exchanger unit **106** may actually begin to transfer heat from the hotter air to water **105** rather than from the water **105** to the air as intended.

Accordingly, in certain embodiments, heat exchanger unit **106** may include a thermostatic control for monitoring the periodic, continual, or on-demand monitoring of the temperatures of water and/or air being received by heat exchanger unit **106**. If the thermostatic control detects that the temperature of the ambient air is less than the temperature of water **105**, the flow of water to heat exchanger unit **106** may be maintained. However, where the thermostatic control detects that the temperature of the ambient air has exceeded the temperature of water **105**, the flow of water to heat exchanger unit **106** may be stopped. For example, where the temperature of water **105** is 120 degrees Fahrenheit, the flow of water may be stopped when the temperature of the air within affected area exceeds 120 degrees Fahrenheit. In particular embodiments, a person responsible for performing the treatment may enter affected area **102** and turn off faucet **104** that is supplying water **105** to heat exchanger unit **106**. Alternatively, heat exchanger unit **106** may include a valve that is automatically or manually closed to prevent the flow of water **105** to heat exchanger unit **106** when the temperature of the ambient air exceeds that of water **105**.

In certain embodiments, affected area **102** may also include at least one air mover **112** positioned proximate to heat exchanger unit **106** and/or electric heater **110** for further distributing the heat emitted by heat exchanger unit **106** and/or electric heater **110**. Air movers **112** may include standard propeller type fans or any other suitable devices for producing a current of air that may be used to circulate and prevent rising of the air emitted by heat exchanger **106** and/or electric heater **110**.

In certain embodiments, the output side of air mover **112** may be configured to direct air toward hard to heat areas and/or contents of affected area **102**. For example, affected area **102** may include an exterior wall, the outside of which may be exposed to cold outside temperatures. As a result, the exterior wall may be harder to heat than certain other portions

of affected area **102**. An air mover **112** may therefore be positioned to direct heated air toward the exterior wall in order to more effectively heat the exterior wall.

In certain embodiments, the output side of air mover **112** may be configured to direct air output by air mover **112** along the floor of affected area **102** to further aid in the circulation of heated air and prevention of temperature stratification (as it is generally recognized that heated air **108** will rise as it exits heat exchanger unit **106** and/or electric heater **110**). For example, the configuration of output side of air mover **112** may be such that the heated air is directed towards the baseboards or floor of affected area **102**. In certain embodiments, the output side of air mover **112** may include a modified circle that includes on elongated corner configured to direct air in a generally downward direction. An example of such an air mover may be that sold under the name Phoenix Axial Air Mover with FOCUS™ Technology or Quest Air AMS 30 by Therma-Scor, L.L.C., which is described in U.S. Pat. No. 7,331,759 issued Marco A. Tejeda and assigned to Technologies Holdings Corp. of Houston, Tex.

Although FIG. **1** depicts only a single air mover **112** as being included in system **100**, one or more additional air movers **112** may also be selectively positioned relative to heat exchanger **106**, electric heater **110**, or another air mover **112** to promote the circulation of air through affected area **102** in a desired direction. For example, air movers **112** may be positioned relative to heat exchanger unit **106** and/or electric heater **110** such that a clock-wise or counter-clockwise airflow pattern is achieved through affected area **102**. Additionally, one or more air movers **112** may be positioned along walls and pointed in a direction to further facilitate the desired circulation pattern. One or more air movers **112** may be positioned to promote circulation through closets or other hard-to-heat areas within affected area **102**. For example, sliding closet doors may be moved to a center position in the doorway. An air mover **112** may then be positioned to blow the heated air **108** into the opening on one side of the door and allowed to exhaust out the opening on the other side of the door.

As described above, hot water **105** may be transported to heat exchanger unit **106** and then through a pipe coil **206** (shown in FIG. **2**). As described above, heat exchanger units **106** may receive the water **105** at a temperature that is greater than 120 degrees Fahrenheit, in certain embodiments. However, as heat exchanger unit **106** transfers the thermal energy in water **105** to air **208** that is received by heat exchanger unit **106**, the temperature of water **105** may decrease. For example, the temperature of water **105** may decrease approximately 10 degrees as the fluid passes through heat exchanger unit **106**. Accordingly, where water **105** is received by heat exchanger unit **106** at a temperature on the order of 120 to 130 degrees Fahrenheit, water **105** may exit heat exchanger unit **106** at a temperature on the order of approximately 110 to 120 degrees Fahrenheit. As another example, where water **105** is received by heat exchanger unit **106** at a temperature that is substantially equal to 140 degrees Fahrenheit, water **105** may exit heat exchanger **106** at a temperature that is substantially equal to 130 degrees Fahrenheit. A design of heat exchanger unit **106** incorporating a counter flow design for the flow of water and air may be preferred to provide maximum heat exchange between the fluids.

As depicted in FIG. **1**, a hose **118** may be used to transport water **105** from heat exchanger unit **106**, in certain embodiments. Accordingly, a first end of hose **118** may couple to heat exchanger unit **106**, and a second end of hose **118** may be positioned proximate a drain **120**. At least one of the respective ends of hose **118** may include "quick-connect" coupling to attach to heat exchanger unit **106**. The diameter of hose **118** may be selected to handle the volume of water being expelled by heat exchanger unit **106**. For example, hose **118** may have a diameter within a range of approximately ¾ to 1 inch, in particular embodiments. It is generally recognized, however, hose **118** may be of any suitable diameter for removing water **105** from system **100**. Likewise, heat exchanger unit **106** may include an outlet port of any size and configuration to facilitate the coupling of hose **118** to heat exchanger unit **106**.

In a particular embodiment, drain **120** may include the toilet. For example, the second end of hose **118** may be positioned inside the toilet such that water expelled by heat exchanger unit **106** is pushed down the toilet and out of affected area **102**. In other embodiments, drain **120** may include any one of a sink drain, shower drain, bathtub drain, or a floor drain. In still other embodiments, drain **120** could include an open window. Thus, though the term "drain" is used, the term refers to any mechanism for removing water **105** from the system. In certain embodiments, the second end of hose **118** may be adapted for or connected to a device to insure that the second end of hose **118** remains in position relative to drain **120** to prevent hose **118** from becoming dislodged and causing water damage to affected area **102**.

Some items or areas within affected area **102** may be considered hard to heat areas. Such items or areas may include items stored in closets and drawers. Large soft items such as couch cushions and mattresses may also be considered hard-to-heat items. Hard-to-heat items may not reach the temperature required to kill the bed hugs or other pests during the treatment process unless adequate steps are taken to ensure complete and thorough heating. Accordingly, additional measures may be taken to ensure thorough distribution of heat through affected area **102** and its infested contents, in some instances.

As one example, heat from the hoses carrying water **105** may be transferred to hard-to-heat areas and items. Specifically, one or more of hose **114** and/or hose **118** may be coiled in a pile. The coiled hose **114** or **118** may be placed in a hard-to-heat area such as a closet or a corner. The hoses **114** and **118**, which transport hot water **105** may transfer heat that may be used to elevate the temperature of a portion of affected area **102** that might otherwise not reach the desired temperature. Since hose **114** may transport water at a higher temperature than hose **118**, hose **114** may be especially effective in providing additional thermal energy to hard-to-heat areas.

It is also recognized that tightly packed contents within affected area **102** may be resistant to being heated completely throughout. This may be particularly true for the contents within closets and drawers. For example, items hung on hangers that are closely packed together may be heated to the desired temperature on some exposed surfaces but the centers of such items may not reach temperatures required to kill any hugs or other pests located on such items. To ensure thorough heating, the items within closets or other tight spaces may be separated such that each item may be sufficiently enveloped in the heat emitted from system **100**. Similarly, stacked articles such as clothing or towels may be separated so that the items do not touch one another. As a result, heated air may more readily circulate around and through the items.

As another example, furniture may be positioned at least six to 12 inches away from walls to facilitate air flow into the furniture and through the room. Additionally, the cushions from a couch may be removed and separated. Mattresses and box springs may be separated from one another and turned on their sides and propped against each other to form an upside

down "V". Positioning the mattress and box springs in this manner facilitates air flow across the surfaces having the most surface area.

In some instances, merely separating the items may not ensure thorough and complete heating of the articles. A more effective method for providing thorough and complete treatment of the items may include placing the items directly on the hoses **114** and **118** that are used to transport water **105**. Accordingly, items may be removed front closets and drawers in some instances. Likewise, items that are stacked or piled may be separated. The items from the closets, drawers, and piles may then be placed on top of hoses **114** and **118**. As just one example, the cushions from a couch or other piece of furniture may be removed and placed on the hoses. Heat may then be transferred directly through the hoses into the couch cushions or other articles. Bed bugs or other pests that have infested the couch cushions may be killed when the couch cushions absorb enough heat from the hose to raise the internal temperature of the couch cushion to a temperature greater than 120 degrees Fahrenheit.

Additionally or alternatively, a person responsible for performing the treatment of affected area **102** may enter the affected area **102** and rearrange hard-to-treat items midway through the treatment process. Stated differently, a person may enter the affected area **102** and specifically expose its contents to the high temperature ambient air in the affected area **102**. For example, midway through the treatment process, the person may individually expose articles such as clothing, pillows, bedding, towels, and other soft items to the high temperature ambient air. Where the ambient air in affected area **102** has reached the required temperature for killing the bed bugs or other pests, exposing the items to the high temperature ambient air may increase the internal temperature of the item to a level sufficient to rid the item of the bed bugs or other insects.

Various modifications may be made to system **100**. For example, though target temperatures of at least 120 and 140 degrees Fahrenheit are described above, these are merely examples of suitable temperatures that may be used to effectively rid an affected area **102** of a bed bug or other insect infestation. Additionally, although water source **104** is described as including a preexisting water source within enclosed area **102**, it is generally recognized that any source of hot water may be used in conjunction with the system **100** depicted in FIG. **1**. Likewise, though water is described as providing the heat source for system **100**, it is recognized that ethylene glycol, a combination of water and ethylene glycol, or any other fluid appropriate for convective heat transfer may be used.

As still another example modification to system **100**, it is recognized that it multiple heat exchanger units **106** and electric heaters **110** may improve the efficiency and effectiveness of system **100**, in certain embodiments. For example, the number of heat exchanger units **106** and electric heaters **110** provided in an affected area **102** may depend upon the square feet to be treated and/or the volume or flow rate of water **105** that is provided by faucet **104**. Other factors, such as whether the affected area **102** is above or below grade and whether the affected area **102** is cluttered with an excessive amount of contents, may also affect the number of heal exchanger units **106** and electric heaters **110** that should be included in system **100**.

FIG. **3** illustrates an example method **300** for pest control, according to certain embodiments. The method begins with the preparation of the affected area at step **302**. In a particular embodiment, preparing the affected area **102** may include capping any sprinkler heads with insulating caps. Insulating caps may include a hollow, modified-hemispherical shaped Styrofoam cover that is attached to the sprinkler head, in certain embodiments, dry-ice can be placed inside the insulating cap to cool the sprinkler heads during the treatment process and further ensure that the sprinkler heads will not trigger during the treatment process. Additionally, preparing the affected area may include removing heat sensitive contents from the infested area. Heat sensitive contents may include any material, equipment, or other contents that could be harmed by temperatures that reach or exceed approximately 120 degrees Fahrenheit. Items that fall within this category may be treated separately offsite.

At step **304**, the equipment used in the treatment process is prepared. Preparation of the equipment may include positioning heat exchanger unit **106** within the affected area **102**. Additionally, preparing the equipment may include connecting a hose **114** to both of a faucet **104** and heat exchanger unit **106**. Additionally, a hose **118** may be connected to heat exchanger unit **106** and then positioned proximate to a drain. Further preparation of the equipment may include placing electric heater **110** and air mover **112** in the appropriate locations within affected area **102**. Heat exchanger unit **106** and air movers **112** may then be plugged into electric supply **116** and powered on.

Additional preparations may include the placement of one or more infrared and/or wireless thermometers within affected area **102**. For example, infrared and/or wireless thermometers may be placed in the more insulated areas that are harder to thoroughly heat. For example, the thermometers may be placed in corners where poor air flow is anticipated. The thermometers may also be placed under furniture or under stacks of clothing or other soft articles. In certain embodiments, wireless thermometers may communicate wirelessly with one or more computers or other control centers. Wireless data-logging software may be used to record the internal temperature of affected area **102** both prior to and during the treatment process.

At step **306**, water **105** is supplied to heat exchanger unit **106**. Specifically, and as described above, a faucet **104** may be turned to the hottest setting. Faucet **104** may also be turned on at full volume. The hot water **105** may then be transported from faucet **104** to heat exchanger unit **106**. Heat exchanger unit **106** operates to hydronically heat the ambient air in the affected area **102**, at step **308**. Specifically, heat exchanger unit **106** may operate to increase the temperature of ambient air within affected area **102**. In a particular embodiment, the heat exchanger unit **106** may transfer the heat in water **105** to the ambient air that is blown through beat exchanger unit **106**.

In certain embodiments, heat exchanger unit **106** receives water **105** at a first temperature that may be equal to or greater than 120 degrees Fahrenheit. In contrast, the ambient air **208** may be received by heat exchanger unit **106** at a second temperature. At the beginning of the treatment process, the temperature of ambient air **208** that is received by heat exchanger unit **106** may be substantially equal to normal room temperature. The temperature difference between water **105** at the first temperature and ambient air **208** results in heat transfer from water **105** to ambient air **208** as it is blown through heat exchanger unit **106**.

At step **310**, the air emitted by heat exchanger unit **106** is electrically heated. In certain embodiments, an electrical resistance heater may be used to further increase the temperature of the ambient air within affected area **102**. Electric heater **110** may operate to "boost" or "amplify" the heat generated by heat exchanger unit **106**. One or more air movers **112** may then be used to promote the distribution of heated air that is emitted by one or both of heat exchanger unit **106** and

electric heater **110**. The heated air may be cycled through the room and may be returned to heat exchanger unit **106** where it is again pushed through heat exchanger unit **106** to result in a further increase in the temperature of the air. Air may be circulated through system **100** in this manner until the combination of heat exchanger unit **106** and electric heater **110** results in the temperature of the ambient air being raised to a target temperature greater than 120 degrees Fahrenheit.

At step **312**, the temperatures of the ambient air in affected area **102** and/or the temperature of water **105** may be monitored. For example, thermostats, infrared thermometers, and/or wireless thermometers may be used to determine the temperature of water **105** supplied to heat exchanger unit **106** and/or the temperature of the air within affected area **102**. The temperature of water **105** may be measured as it is leaving faucet **104**, as it is entering or exiting heat exchanger unit **106**, or at any other point prior to exiting system **100**. The temperature of ambient air may be measured as it is entering heat exchanger unit **106**, as it is leaving heat exchanger unit **106**, as it is entering electric heater **110**, as it is exiting electric heater **110**, or at any location within affected area **102**.

In a particular embodiment, heat exchanger unit **106** may include a thermostatic control allowing a user to set a desired temperature level for the air being received by heat exchanger unit **106**. In other embodiments, the thermostatic control may be remote from the heat exchanger unit **106** such that the temperature of a specific portion of affected area **102** to be monitored and controlled. Additionally or alternatively, multiple thermometers or thermostatic controls may be provided at multiple locations within affected area **102** to allow the different components of system **100** to be controlled separately. One or more of the thermostats, thermometers, or controls may act as a "high limit" to prevent overheating of temperature sensitive regions with affected area **102**. The monitoring of the temperatures of water **105** and air may be continuous, periodic, or as demanded.

At step **314**, a determination may be made as to whether the temperature of the ambient air is greater than the temperature of water **105**. Such a determination may be made continuously, periodically, or as demanded and may be appropriate where the desired target temperature for the affected area **102** is greater than the temperature of water **105** that is supplied to heat exchanger unit **106**. For example, such a determination may be appropriate where, the temperature of water **105** is 120 degrees Fahrenheit but a target temperature of greater of than 120 degrees Fahrenheit is desired for the ambient air within affected area **102**. As the temperature of the ambient air within affected area **102** surpasses the temperature of water **105**, the operation of heat exchanger unit **106** may actually be counterproductive since heat exchanger unit **106** generally operates to transfer heat from the hotter medium to the cooler medium. In such a scenario, operating heat exchanger unit **106** after the temperature of the air surpasses the temperature of fluid **105** may actually result in the transfer of heat from the hotter air to water **105** rather than the continued heating of the ambient air.

If it is determined, at step **314**, that the temperature of the air is not greater than the temperature of water **105** being supplied to heat exchanger unit **106**, the method returns to step **306**. The supply of water **105** to heat exchanger unit **106** is maintained, and the air is hydronically and electrically heated at steps **308** and **310**, respectively. The method may continue in this manner cycling through steps **306-314** until a determination is made at step **314** that the temperature of ambient air is greater than the temperature of water **105** being supplied to heat exchanger unit **105**. At such time, the supply of water **105** to heat exchanger unit **106** may be stopped. For example, a person responsible for performing the treatment may enter affected area **102** and turn off faucet **104** that is supplying water **105** to heat exchanger unit **106**. As another example, heat exchanger unit **106** may include a valve that is automatically or manually closed to prevent the flow of water **105** to heat exchanger unit **106** when the temperature of the ambient air exceeds that of water **105**.

At step **318**, the electric heating of the air is continued until the temperature of ambient air reaches the target temperature. As described above, a target temperature that is greater than 120 degrees Fahrenheit may be sufficient to kill bed bugs and other insects within affected area **102**, in certain embodiments. However, a target temperature of greater than 140 degrees Fahrenheit may be desired to ensure that the entire area and its contents are thoroughly heated to a temperature greater than the minimum temperature required.

After the target temperature has been maintained for a sufficient amount of time to result in the killing of the bed bugs and/or other pests, a shut down of the equipment may be initiated at step **320**. If water **105** is being supplied to heat exchanger unit **106**, the flow of water **105** may be stopped. Heat exchanger unit **106** and electric heater **110** may be turned off. Any remaining water **105** in system **100** may be drained out of the system components and routed to drain **120**. To initiate the cooling of affected area **102** and its contents, air mover **112** may be repositioned. For example, an air mover **112** may be used to blow the heated air out of affected area **102**. Additionally or alternatively, an air mover **112** may be positioned to blow cooler air into the affected area **102**.

In certain embodiments, the flow of water **105** may be maintained. However, the temperature of the water may be adjusted. By switching the faucet **104** to cold water, for example, hose **114** can deliver cold water **105** to heat exchanger unit **106** transferring heat from the ambient air to the water **105**. This may cool the affected area more quickly if the heated air can not be easily exhausted from the affected area. Hoses **114** and **118** may be removed when they have cooled enough to be comfortably handled. Finally, the equipment may be removed from affected area **102**, and the contents of affected area **102** may then be returned to their original places.

FIG. **4** illustrates an example heat pump system **400** for pest control, according to certain embodiments of the present disclosure. In general, system **400** includes equipment and components for heating at least a portion of an affected area **402** and its contents to a temperature sufficient to kill bed bugs and other insects that inhabit the affected area **402**. Similar to system **100** that is described above with regard to FIG. **1**, the components of system **400** cooperate to increase the temperature of affected area **402** and the contents contained therein to result in killing bed bugs and other insects or pests. In certain embodiments, for example, the temperature of affected area **402** may be increased to a temperature that is substantially equal to or greater than 120 degrees Fahrenheit. In a particular embodiment, the temperature of affected area **402** may be increased to a temperature that is equal to or greater than 140 degrees Fahrenheit.

Similar to system **100** described above, a water source **404** provides a supply of water **405** via one or more hoses to a heat exchanger unit **406** within the affected area **402**. Faucet **404**, water **405**, and heat exchanger unit **406** may be substantially similar to faucet **104**, water **105**, and heat exchanger unit **106** described above. As such, those components are not described in detail with respect to FIG. **4**. However, because a system **400** incorporating heat pump **408** may more efficiently and more effectively increase the temperature of the ambient air of affected area **402** than a system without heat

pump **408**, the temperature of water **405** entering system **400** may be lower than that described above. For example, water **405** may be received by system **400** at a temperature that is substantially equal to or greater than 45 degrees Fahrenheit, in certain embodiments.

Additionally, whereas water **105** exiting heat exchanger unit **106** is directed out of system **100**, water **405** is directed to a heat pump **408** after exiting heat exchanger unit **406**. Likewise, whereas heated air **108** exiting heat exchanger unit **106** is directed to a electric heater **110**, heated air **410** is directed to heat pump **408**, which is then used to further increase the temperature in heated air **410**.

FIG. **5** illustrates an example heat pump unit **408** for use in conjunction with the heat pump system **400** depicted in FIG. **4**, according to certain embodiments. As depicted, heat pump unit **408** includes an evaporator component **502**, a condenser component **504**, a compressor **506**, and an expansion device **508**. Evaporator component **502** operates to transfer the heat within water **105** to refrigerant **510**. The heat within refrigerant **510** is then transferred to air that is blown through condenser component **504**. In this manner, heat pump **408** may be used to "boost" or "amplify" the heat generated by heat exchanger unit **406**. As a result, the temperature of the ambient air in affected area **402** may be more efficiently and more effectively brought up to the target temperature.

In certain embodiments, heat pump **408** may operate to produce up to three times more heat than a system such as system **100** that does not have a heat pump **408** and relies solely on a heat exchanger unit and an electrical heater for the generation of heat. Stated differently, whereas an electrical heater that is powered by a 115 V electrical outlet may generate only 4500 BTUs of heat, heat pump that is powered by the same electrical outlet may generate approximately 15,000 BTUs of heat.

Specifically, water **405** is received by heat pump **408** via a supply line **512**. The heated water **405** is received at a first temperature and is circulated through evaporator component **502**. Evaporator component **502** operates to transfer heat from water **405** to a refrigerant **510** that is received from the expansion device **508**. Specifically, refrigerant **510** enters evaporator component **502** while in a liquid state. While in evaporator component **502**, refrigerant **510** absorbs heat from water **405**. As as result, refrigerant **510** is transformed from a liquid state to a vapor state. The vaporous refrigerant **510** is then directed to the compressor **506**.

The compressor **505** compresses the refrigerant **510** to a higher temperature and pressure. Condenser component **504** is configured to transfer heat from the vaporous refrigerant **510** to air that is flowing through condenser component **504**. In certain embodiments, condenser component **504** receives air **410** emitted by heat exchanger unit **406** and operates to further increase the temperature of the air **410** by transferring the heat from the vaporous refrigerant **510** to air **410**. As the heat is transferred from refrigerant **510** to air **410**, refrigerant **510** again undergoes a state change. Specifically, the refrigerant **510** may be transformed from the vapor state to the liquid state. The air is then emitted from heat pump **408**. The liquid refrigerant **510** is returned to the expansion device **508**. A compressor **506** may operate to cycle the refrigerant **510** through heat pump **408**.

Some heat pump designs may not tolerate water temperatures above a predefined limit. For example, some heat pump designs may not tolerate water temperatures above 90 degrees Fahrenheit. If the evaporator temperature becomes too high, compressor **506** may overheat and stop functioning. In order to prevent this failure, heat pump **408** may include sensors and/or controls for protecting the compressor **506** from overload in certain embodiments. The sensors and controls may operate to monitor and control the flow rate and the temperature of water entering the evaporator component **502** of heat pump **408**. Though the sensors and controls may be integrated as part of heat pump **408**, it is recognized that the sensors and controls may be an external device in certain embodiments.

In a particular embodiment, for example, heat pump **408** may include a mechanical or electronic water tempering valve or a thermostatic mixing valve. The tempering valve may be operated mechanically or electronically and may used to maintain the temperature of water within a predefined operating range. In certain embodiments, the tempering valve may include two quick connect or other connections for receiving both hot and cold water through two respective hoses. The tempering valve may then mix the hot and cold water from the two supplies to maintain a specified output water temperature. The specified output water temperature may be adjustable by a user or it may be fixed, as desired. The mixed hot and cold water may be directed to a suitable drain after it leaves heat pump **408**.

As an alternative to a water tempering valve or in addition to a water tempering valve, one or more sensors or controls may be used to prevent the evaporator component **502** from failing. For example, the sensors or controls may be used to maintain the temperature of the heat pump evaporator component **502** within a specified range by controlling the water flow rate provided to heat pump **408**. In particular embodiments, the valve or metering device may include an electrical or mechanical valve that may be adjustable by a user or fixed, as desired. Because the valve or metering device that controls the flow rate does not require a connection to a cold water supply in addition to the hot water supply connection previously described, this mechanism for preventing heat pump failure may be preferred to a water tempering valve, in certain embodiments where the structure has a limited number of fixtures.

The heat pump **408** may include a mechanism for selectively controlling the operation of compressor **506** in response to the temperature of water **405**. For example, the control may result in the reduction of compressor capacity or a complete powering down of compressor **506** when the temperature of water **405** becomes too low, in certain embodiments.

Returning to FIG. **4**, water **405** exits heat pump **408** via a hose or other drain line **414**. Hose **414** may be used to transport water **405** out of system **400**, in certain embodiments. Accordingly, a first end of hose **414** may couple to heat pump **408**, and a second end of hose **414** may be positioned proximate a drain **416**. Similar to drain **120** of system **100**, drain **416** may include a toilet, in a particular embodiment. Thus, the second end of hose **414** may be positioned inside the toilet such that water expelled by heat pump **408** is pushed down the toilet and out of affected area **402**. In other embodiments, drain **416** may include any one of a sink drain, shower drain, bathtub drain, or a floor drain. In still other embodiments, drain **416** could include an open window or other outlet. Thus, though the term "drain" is used, the term refers to any mechanism for removing water **405** from system **400**.

In certain embodiments, at least one of the respective ends of hose **414** may include "quick-connect" coupling to attach to heat pump **408**. The diameter of hose **414** may be selected to handle the volume of water being expelled by heat pump **408**. For example, hose **414** may have a diameter within a range of approximately ¾ to 1 inch, in particular embodiments. It is generally recognized, however, hose **414** may be of any suitable diameter for removing water **405** from system

400. Likewise, heat pump 408 may include an outlet port of any size and configuration to facilitate the coupling of hose 414 to heat pump 408.

As depicted, system 400 includes an electric heater 412 as an additional heat source. System 400 is also illustrated as including an air mover 418 to promote circulation of air emitted by any one of heat exchanger unit 406, heat pump 408 and electric heater 412. Electric heater 412 and air mover 418 may be substantially similar to electric heater 110 and air mover 112 described above. As such, electric heater 412 and air mover 418 are not described in detail with respect to FIG. 4. It is recognized, however, that system 400 may include any appropriate number of electric heaters 412 and air movers 418. Such electric heaters 412 and air movers 418 may be arranged in series or in parallel. It is further recognized that electric heater 412 and air mover 416 may be considered optional components that may be omitted from system 400, in certain embodiments.

Various other modifications may be additionally or alternatively made to system 400. For example, though system 400 is described as including a single heat exchanger unit 406 and a single heat pump 408, system 400 may include any appropriate number of heat exchanger units 406 and heat pumps 408 for emitting heat to raise the temperature of the ambient air to the target temperature. Where multiple heat exchanger units are used, the heat exchanger units may be arranged in series or in parallel. Thus, water from faucet 404 may be directed to multiple heat exchanger units in parallel. Alternatively, water from faucet 404 may be directed to the multiple heat exchanger units in series. Likewise, where multiple heat pumps are used, the heat pumps may be arranged in series or in parallel with regard to the air stream. As still a further modification, water from faucet 404 may be directed to heat exchanger unit 406 and heat pump 408 in parallel rather than in series as shown.

As another example modification, though system 400 is described as including heat exchanger unit 406, this component may also be omitted from system 400 in certain embodiments, in some embodiments, heat exchanger unit 406 may be sufficient by itself to thoroughly heat the affected area 402 to the target temperature. Thus, where the temperature of water 405 is high enough and where heat pump 408 operates to efficiently and effectively increase the temperature of ambient air in affected area 402 to the target temperature, heat exchanger unit 406 may be omitted from system 400. In such an embodiment, water 405 may be transported directly from faucet 404 to heat pump 408. Heat pump 408 may then operate to first transfer the heat within water 405 to refrigerant 510 and then transfer the heat within refrigerant 510 to the ambient air. As another example modification, though the target temperature of affected area 402 may be a temperature that is greater than 120 degrees Fahrenheit, this is merely one example of a suitable temperature that may be used to effectively rid an affected area 402 of a bed bug or other insect infestation.

FIG. 6 illustrates an example heat pump method 600 for pest control, according to certain embodiments of the present disclosure. The method begins with the preparation of the affected area at step 602. As described above, preparing the affected area 402 may include capping any sprinkler heads with insulating caps. Additionally, preparing the affected area 402 may include removing heat sensitive contents from the affected area 402. Heat sensitive contents may include any material, equipment, or other contents that could be harmed by temperatures that reach or exceed approximately 120 degrees Fahrenheit. Items that fall within this category may be treated separately offsite.

At step 604, the equipment used in the treatment process is prepared. Preparation of the equipment may include positioning heat exchanger unit 406 and heat pump 408 within the affected area 402. Additionally, preparing the equipment may include connecting a hose to a faucet 404 and at least one of heat exchanger unit 406 and heat pump 408. Additionally, a hose 414 may be connected to heat pump 408 and then positioned proximate to drain 416. Further preparation of the equipment may include placing electric heater 412 and air mover 418 in the appropriate locations within affected area 402. Heat exchanger unit 406, heat pump 408, electric heaters 412, and air movers 418 may then be plugged into an electric supply and powered on.

Additional preparations may include the placement of one or more infrared and/or wireless thermometers within affected area 402. For example, infrared and/or wireless thermometers may be placed in the more insulated areas that are harder to thoroughly heat. For example, the thermometers may be placed in corners where poor air flow is anticipated. The thermometers may also be placed under furniture or under stacks of clothing or other soft articles. In certain embodiments, wireless thermometers may communicate wirelessly with one or more computers or other control centers. Wireless data-logging software may be used to record the internal temperature of affected area 402 both prior to and during the treatment process.

At step 606, water 405 is supplied to one or both of heat exchanger unit 406 and heat pump 408. Specifically, and as described above, a faucet 404 may be turned to the hottest setting and turned on at the fullest volume. The hot water 405 may then be transported from faucet 404 to one or both of heat exchanger unit 406 and heat pump 408. As described above, heat exchanger unit 406 operates to hydronically heat the ambient air in the affected area 402, at step 608. Specifically, heat exchanger unit 406 may operate to increase the temperature of ambient air within affected area 402. In a particular embodiment, the heat exchanger unit 406 may transfer the heat in water 405 to the ambient air that is blown through heat exchanger unit 406.

In certain embodiments, heat exchanger unit 406 receives water 405 at a first temperature that may be equal to or greater than 45 degrees Fahrenheit. In contrast, the ambient air may be received by heat exchanger unit 406 at a second temperature. At the beginning of the treatment process, the temperature of ambient air that is received by heat exchanger unit 406 may be substantially equal to normal room temperature. In certain embodiments, the temperature difference between water 405 at the first temperature and the ambient air results in heat transfer from water 405 to the ambient air as it is blown through heat exchanger unit 406.

At step 610, heat pump 408 is used to amplify or boost the heat generated by heat exchanger unit 406. Specifically, heat pump 408 may receive water 405 after it is expelled by heat exchanger unit 406. The water may be received by heat pump 408 at a temperature that is slightly less than the temperature at which the water 405 was received by heat exchanger unit 406. For example, the water 405 may be received by heat pump 408 at a temperature that is approximately ten degrees less than the temperature at which water 405 was received by heat exchanger unit 406. Similar to heat exchanger 406, heat pump 408 may further transfer the heat within water 405 to air being blown through heat pump 408. Specifically, evaporator component 502 may transfer the heat within water 405 to refrigerant 510. A condenser component 504 may then transfer the heat within the refrigerant 510 to the air that is being emitted by heat pump 408.

At step **612**, the air emitted by heat pump **408** is electrically heated. For example, an electrical resistance heater may be used to further increase the temperature of the ambient air within affected area **402**. Electric heater **412** may operate to further increase the temperature of the air emitted by heat pump **408**. One or more air movers **418** may then be used to promote the distribution of heated air that is emitted by heat exchanger unit **406**, heat pump **408**, and electric heater **412**. The heated air may be cycled through the affected area and may be returned to heat exchanger unit **406** and/or heat pump **408** where it is again pushed through the components of system **400** to result in a further increase in the temperature of the air. Air may be circulated through system **400** in this manner until at least one of heat exchanger unit **406**, heat pump **408**, and electric heater **412** or some combination of these components results in the temperature of the ambient air being raised to the target temperature. As described above, a target temperature that is greater than 120 degrees Fahrenheit may be sufficient to kill bed bugs and other insects within affected area **402**, in certain embodiments. In a particular embodiment, however, a target temperature of greater than 140 degrees Fahrenheit may be desired to ensure that the entire area and its contents are thoroughly heated to a temperature greater than the minimum temperature required. The equipment may be adjusted as needed until the target temperature is obtained. For example, equipment may be repositioned as needed to equalize the rate of heating across affected area **402**. Additionally, where possible, the temperature of water **405** may be increased if more heat is desired within affected area **402**.

After the target temperature has been maintained for a sufficient amount of time to result in the killing of the bed bugs and/or other pests, a shut down of the equipment may be initiated at step **614**. For example, the flow of water **405** may be stopped. Heat exchanger unit **406**, heat pump **408**, and electric heater **412** may be turned off. Any remaining water **405** in system **400** may be drained out of the system components and routed to drain **416**. To initiate the cooling of affected area **402** and its contents, air mover **418** may be repositioned. For example, an air mover **418** may be used to blow the heated air out of affected area **402**. Additionally or alternatively, an air mover **418** may be positioned to blow air that is outside affected area **402** into the affected area. By switching the faucet **404** to cold water, hose **420** can deliver cold water **405** to heat exchanger unit **406** transferring heat from the ambient air to the water **405**. This will cool the affected area quickly if the heated air can not be easily exhausted from the affected area. Any hoses coupling the system components may be removed when they have cooled enough to be comfortably handled. Finally, the equipment may be removed from affected area **402**, and the contents of affected area **402** may then be returned to their original places.

Although the present invention has been described with several embodiments, diverse changes, substitutions, variations, alterations, and modifications may be suggested to one skilled in the art, and it is intended that the invention encompass all such changes, substitutions, variations, alterations, and modifications as fall within the spirit and scope of the appended claims.

What is claimed is:

1. A method for killing pests in an affected area of a structure, comprising:

positioning a heat exchanger unit within an affected area;

coupling a first end of an inlet hose to a faucet;

coupling a second end of the inlet hose to an inlet port of the heat exchanger unit such that the heat exchanger unit may receive a flow of water from the faucet, the heat exchanger unit operable to generate heated air by transferring heat from the flow of water received from the faucet to air flowing through the heat exchanger unit;

positioning an electric heater proximate to the heat exchanger unit, the electric heater operable to further heat the heated air emitted by the heat exchanger unit to a target temperature greater than 120 degrees Fahrenheit, the further heated air being emitted into the affected area

monitoring a temperature of the air from the affected area;

determining that the temperature of the air is greater than a temperature of the flow of water received by the heat exchanger unit; and

causing the flow of water received by the heat exchanger unit to cease if the temperature of the air is greater than a temperature of the flow of water received by the heat exchanger unit.

2. The method of claim **1**, wherein the heat exchanger unit comprises a valve that is automatically closed to prevent the flow of water to the heat exchanger unit.

3. The method of claim **1**, wherein the faucet comprises one of shower faucet and a sink faucet.

4. The method of claim **1**, wherein the flow of water is supplied to the faucet by a water heating unit for the structure, the method further comprising setting a thermostat of the water heating unit such that a temperature of the flow of water received by the heat exchanger unit is greater than 125 degrees Fahrenheit.

5. The method of claim **1**, further comprising:

coupling a first end of an outlet hose to an outlet port of the heat exchanger unit;

positioning a second end of the outlet hose proximate to a drain such that the flow of water may leave the heat exchanger unit via the outlet port and be discharged into the drain.

6. The method of claim **1**, wherein the structure comprises an apartment building and the affected area comprises an apartment.

7. The method of claim **1**, wherein the structure comprises a hotel and the affected area comprises a hotel room.

8. The method of claim **1**, further comprising positioning an air mover proximate to the electric heater, the air mover being configured to direct heated air emitted by the electric heater along the floor of the affected area in order to prevent temperature stratification.

9. The method of claim **1**, further comprising separating a plurality of contaminated items within the affected area to ensure that each contaminated item is heated throughout to the target temperature.

10. The method of claim **1**, wherein, after the affected area is treated for pests, the heat exchanger unit is further configured to generate cool air by transferring heat from the air flowing through the heat exchanger unit to the flow of water received from the faucet.

11. The method of claim **1**, wherein:

the flow of water is received by the heat exchanger unit at a temperature of approximately 120-130 degrees that is tolerated by an occupant of the structure; and

the portable electric heater is operable to further heat the heated air to a target temperature greater than 140 degrees Fahrenheit.

12. The method of claim **1**, further comprising placing a coil of hose relative to a hard-to-heat area within the structure, the coil of hose configured to transfer heat to the hard-to-heat area by carrying water from the heat exchanger unit.

13. The method of claim 1, further comprising:

placing a fan proximate to the inlet of the heat exchanger unit, the fan operable to direct air into the inlet of the heat exchanger unit; and

operating a thermostatic control to automatically cycle off the fan when the temperature of the air received by the heat exchanger unit is greater than a predetermined threshold.

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